

## PREFRONTAL LOBOTOMY\*

*The Surgical Relief of Mental Pain*

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PREFRONTAL LOBOTOMY<sup>1</sup> is the latest development in the field of psychosurgery, and thus far the most exact and controllable. It is the logical sequel to the local cortical extirpations carried out by Burckhardt<sup>2</sup> in the last century, to the transcortical incisions attempted by Puusepp<sup>3</sup> before the first World War, to the brilliantly conceived prefrontal leucotomies of Egas Moniz<sup>4</sup> and to the drastic prefrontal lobectomies<sup>5</sup> carried out now and again by European and American neurosurgeons. By psychosurgery we wish to designate surgical operations upon the anatomically intact brain, in the effort to relieve mental symptoms. Psychosurgery is thus a far different procedure from the extirpation of tumors, cicatrices and other lesions that are causing symptoms and whose removal is imperative for reasons of survival or health. Psychosurgical operations are comparable to operations upon the sympathetic nervous system or upon the pain pathways of the central nervous system, in that anatomically normal structures are sacrificed in the interest of the health of the patient. Psychosurgery relieves mental pain.

It may be well at the start to admit that considerable prejudice exists in relation to psychosurgery. For many it would seem unjustifiable (to use no stronger term) to sacrifice man's greatest heritage, the frontal lobes, merely in the interest of his greater comfort and freedom from fear and self consciousness. Moreover, a gloomy picture exists of the condition of the individual who has suffered any considerable loss of frontal lobe tissue. We were all brought up on the story of Phineas Gage, the railroad construction foreman of a century ago, whose crow-

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bar was blasted through the top of his head.<sup>6</sup> Some of us have seen the skull and the crowbar. Furthermore, we have followed with interest the studies on the functions of the frontal lobes from the time when Bianchi<sup>7</sup> and Ferrier<sup>8</sup> first called to our attention the changed personalities of the animals operated upon. The "tumor" studies followed, and then the "war injury" studies, and within the past decade there have been many cases of unilateral frontal lobectomy<sup>9</sup> and a few of bilateral frontal lobectomy<sup>10</sup> for tumor or for epileptogenic scars, with critical studies on the remnants of the patients' personalities. Out of these studies has come the picture of the "defrontalized dement," a being without shame and without ambition, lacking in all the finer qualities that make a man what he is, and debased to the level of the brute.

We do not wish to go to the other extreme and claim for patients who have undergone prefrontal lobotomy more than the average quota of virtues. Patients do lose something in the process, and we shall devote considerable time to the presentation of these defects. What we wish to emphasize is that in assessing the results of prefrontal lobotomy, the total behavior of the patient both before and after operation is critically studied, with whatever information can be obtained from the family and close associates of the patient. Just because the patient is relieved of mental distress and is again cheerful is no reason for calling the operation a success, even though a contented drone is more bearable than a complaining one. Enough patients now, have been returned to their homes able to manage them and to work for gain, who previously have necessarily been confined in institutions to make us optimistic about eventual results. It would seem that in certain cases the elimination of part of the activity of the frontal lobes has been of advantage to the total personality.

The problems in prefrontal lobotomy have gone beyond their first stage of hit-or-miss production of destructive lesions of the frontal lobes and waiting to see what the effect would be. With continued study of the procedure over the past six years, we have developed an operative technique that has certain merits of precision, and we have followed all of our 136 patients with periodic surveys, so that we know for these:

1. Where the induced lesions are.
2. What the results are to date.

It is well to conclude this introduction with a brief description of the operative technic.<sup>11</sup>

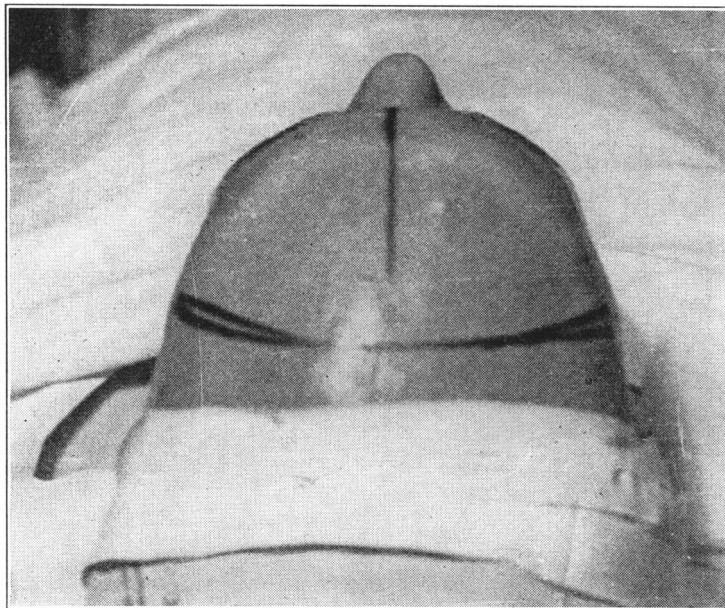


Fig. 1—Markings on the shaved and sterilized scalp indicate the midline and the coronal suture.

#### PREFRONTAL LOBOTOMY

We prefer local anesthesia, since the patient can then report his feelings and ideas as well as respond to tests. Only in disturbed or apprehensive patients is a general anesthetic necessary. The patient's scalp is shaved to the vertex and the coronal suture and midline are marked out on the sterilized scalp. The coronal suture is then exposed on each side by incisions 4 cm. long, going down through skin and muscle, and burr holes are placed in this suture 6 cm. above the zygoma. This opening is enlarged by small rongeur bites in the suture, the dura is opened and an avascular portion of the exposed cortex is penetrated by a sharp knife. The field is then prepared for coöperation of the surgeon and neurologist in making the subcortical incisions (Fig. 1).

The neurologist (or in his absence, the surgeon's assistant) sits behind the surgeon with his eyes in the extended plane of the coronal suture. Since this landmark is so constant and so easily outlined, it is closely adhered to throughout every operation, although deviations may be indicated under special conditions. The surgeon first finds the

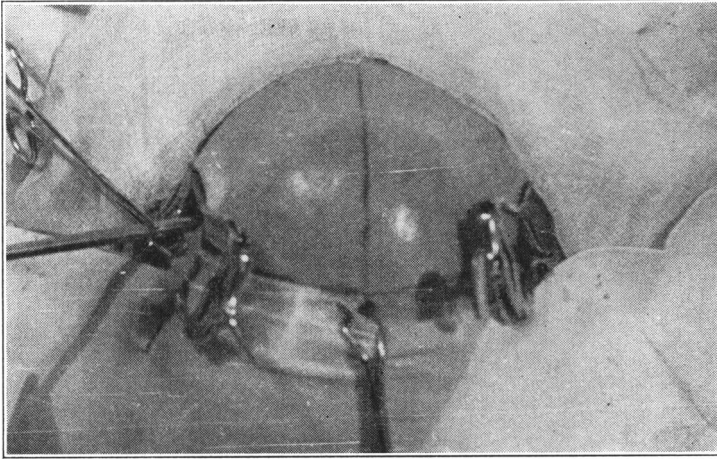


Fig. 2—A blunt knife, with hemostat attached, severs the subcortical white matter in the plane of the coronal suture.

midline by introducing a cannula directly toward the opposite opening. Resistance is usually perceived at a depth of 5 or 6 cm. If no change in resistance is felt, it means that the cannula has penetrated the knee of the corpus callosum; in which case the cannula is withdrawn and angulated toward the vertex until it impinges upon the falx cerebri, but always in the plane of the coronal suture. If the cannula enters the ventricle it is withdrawn and angulated slightly forward, but it does not seem to matter much if the incision does enter the ventricle.

A further landmark is found in the sphenoidal ridge by introducing the cannula downward toward the base of the skull. If the cannula penetrates more than 5 cm. it is probably behind the sphenoidal ridge and in the middle fossa, a dangerous area from the standpoint of bleeding. In such cases, reëxamination of the markings is advisable, since it is imperative to keep the incisions as close as possible to the plane of the coronal suture.

When the surgeon is satisfied with his landmarks, he clamps a hemostat on the shaft of a blunt knife (we use Killian's nasal septum periosteal elevator) and introduces the instrument to a depth short of the midline (beware the anterior cerebral artery!) and begins the fan-like incisions in the frontal lobe (Fig. 2). During this procedure the neurologist guides the surgeon, keeping the knife and the hemostat both in

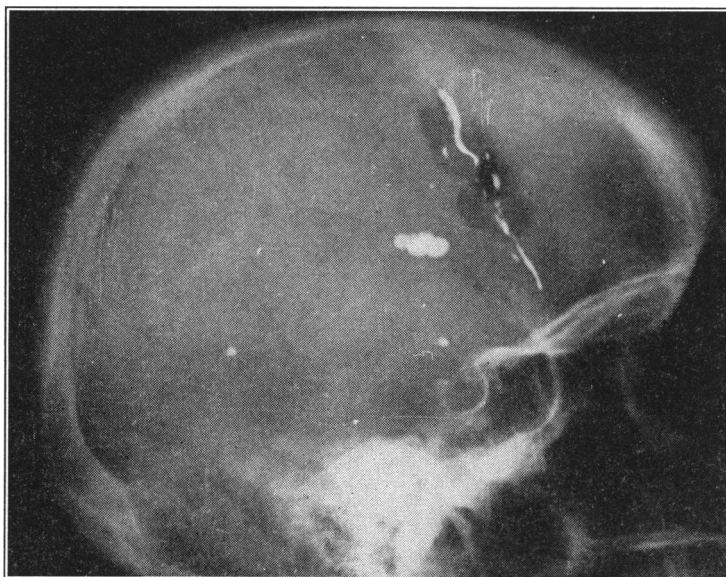


Fig. 3A

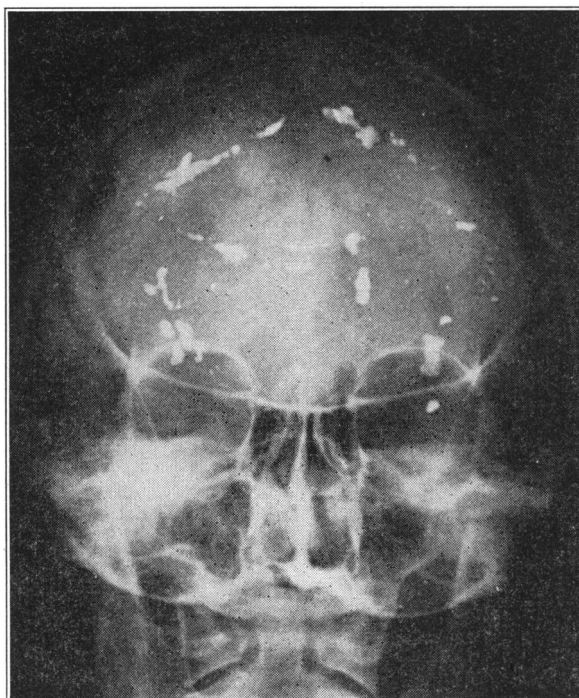


Fig. 3B

Fig. 3A & B.—Lateral (A) and frontal (B) roentgenograms showing the location of the lobotomy incisions.

the plane of the coronal suture, by means of constantly correcting the surgeon's tendency to deviate from this plane. The depth of the incision must be judged by the surgeon, any increased resistance being the signal for withdrawing the instrument as a precaution against lacerating an artery. Once the primary incision has been made, it is safe to deepen the incision by radial thrusts of the knife that will push any intruding artery before it and at the same time reach the more peripheral parts of the white matter in the frontal poles.

The upper and lower half of each frontal pole is thus transected subcortically, or in another manner of speaking, the 4 quadrants of the frontal lobes are sectioned. Bleeding is minimal unless the cortex is trespassed upon. At the end of the operation, iodized oil is introduced into the depths of the incisions for roentgenographic control (Fig. 3).

Secondary operations are not infrequently necessary. In some cases, if the roentgenograms show that the mesial portions have been missed, the incisions are reopened and the knife plunged deeper. In others, new burr holes are placed in the coronal suture or 1 to 2 cm. behind it and 3 cm. lateral to the midline, and fresh incisions made in the white matter of the superior frontal gyrus medially and laterally, to connect with the previous incisions, thus insuring more complete subcortical amputation of the frontal poles.

Shock is minimal and complications are few. The patient is able to stand and walk within an hour after operation, will even offer to get off the operating table and walk back to his room. Such offers are firmly declined! As soon as the stitches are out, he is encouraged to sit up and in a week or so to walk about the hospital. He can usually be discharged in ten days. We mention these facts in order to emphasize the mild effects of lobotomy as compared with lobectomy.

The mental state of the patient alters abruptly with the completion of the incision of the fourth quadrant, irrespective of which quadrant is sectioned last: upper, lower, right or left. Even with three quadrants incised, the conscious patient is still oriented, can carry out intellectual problems of considerable complexity, and, although quieter, may still report anxiety or distress almost as great as before operation. In a matter of seconds after incision of the fourth quadrant, the patient becomes unresponsive, disoriented, confused and is freed completely from his anxieties. Pulse and blood pressure fall rapidly to normal, the extremities become warm and pink, flushing and sweating occur over the ex-

posed forehead and the patient appears to go quietly to sleep. Some patients are more lively and engage the neurologist in lively and sometimes humorous conversation or even sing, on request, some wellknown song, say their prayers and so on. But they are unable to recall anything concerning their immediate surroundings, and even when the skin sutures are being placed, may deny that they have been operated upon. This disorientation is so characteristic that it is used as a yardstick for satisfactory operation. While it does not always occur on the operating table, if it is not present on the first postoperative day, it is likely that the operation will be a failure and that the preoperative symptoms will return within a short time.

#### POSTOPERATIVE CONDITION

The first few postoperative days are marked by phenomena that are quite peculiar to prefrontal lobotomy and are far different from the usual occurrences observed following most intracranial operations. There is no discomfort beyond slight headache, the fever may reach 102° F. for a day or two, the pulse and blood pressure are usually undisturbed, and aside from vomiting and urinary incontinence, there is little of note on the clinical chart. Patients are often reading, or rather, scanning newspapers or magazines on the second day, and they play with objects such as the bed light or the bell cord, or pick at their bandages by the hour. We have found that a rubber doll will absorb a lot of attention and divert it from the bandages. The appetite returns by the third day and the sphincters usually come under control within that same period. By the end of a week orientation returns, the patient still spends a good deal of time in relaxed idleness, and responds pleasantly when aroused. There is no aphasia and no ataxia, the only neurologic signs noted during this early period being a smoothing out of the facial expression, plateau type of speech and incontinence. A fleeting Babinski sign may be found, but seldom reflex grasping. Patients who have been sick less than a year usually admit freely that their worries and depression have lifted; those who have been sick for a long time will continue the same complaints if they are asked about them, but without the emotional intensity that marked the preoperative condition. Not infrequently, there are witty replies and a dash of profanity. Restlessness, talkativeness and singing are occasionally noted, but disturbed behavior is quite uncommon. With the beginning of the second week the

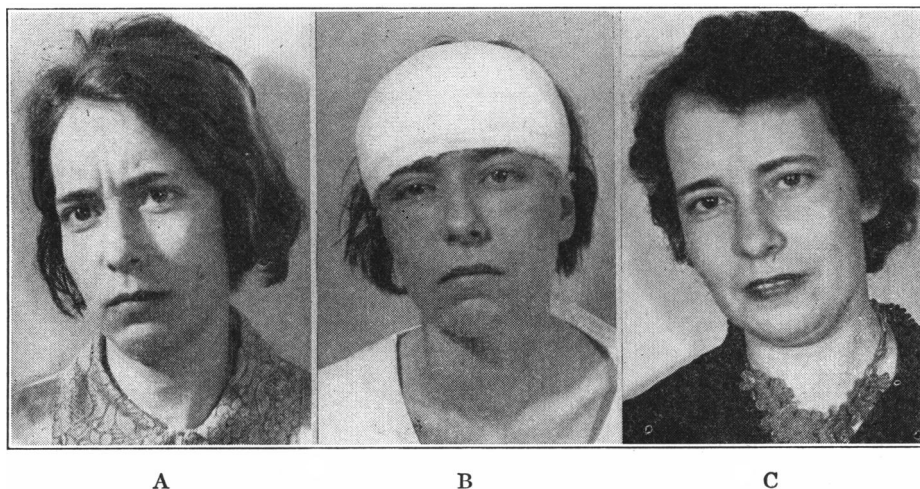


Fig. 4—Characteristic alterations in facial expression following prefrontal lobotomy. Schizophrenic of four years institutionalization. A. Before operation. B. Five days after operation. C. Six months after operation.

inertia clears, or the hyperactivity dies down and the patient is allowed to go home or to some institution for convalescent care (Fig. 4).

The convalescent period may last but three weeks or it may last for a year or more, depending upon the chronicity of the case, the operative success, the previous behavior of the patient and so on. It is during this period that the patient is learning to readjust to living conditions with an altered personality, and also bringing that altered personality into line with the accepted norms of his group. It is not always an easy task, either for the patient or for the family.

#### SOCIAL BEHAVIOR

The individual who has undergone prefrontal lobotomy is different from his prepsychotic self, although some indulgent families do not recognize the difference. He is apt to be more indolent, although some patients are very industrious; he is outspoken, saying the first thing that comes into his head rather than waiting an instant to judge the effect his response will have upon his audience. Patients acknowledge being hasty, undiplomatic, tactless. There is a certain directness of reply, maybe couched in the vernacular, that arrests the attention of the listener. When patients have said or done something that has undesirable con-



TABLE I  
STATUS OF PATIENTS FOLLOWING PREFRONTAL LOBOTOMY

<i>Disease</i>	<i>No.</i>	<i>Regularly Employed</i>	<i>Studying or Partially Employed</i>	<i>House- Keeping</i>	<i>At Home</i>	<i>Insti- tution</i>	<i>Dead</i>
Involuntional Depressions	62	6	4	27	11	6	8
Obsessive Tension States	30	12	4	5	7		2
Schizophrenias	31	4	7	4	11	4	1
Psychoneurosis	8	4		2		2	
Undifferentiated (Schizoid)	5	1	1	1	1	1	
Totals	136	27	16	39	30	13	11

sequences, they are genuinely sorry and often apologize. The emotional reactions are brisk, but shallow and short-lived. Patients laugh more, and flare up in petulance, but the storm is over almost before the family can prepare for it. There is none of the brooding melancholy, the hurt feelings, the grim silences. Consequently these patients can be treated a good deal like children, with affectionate references to their irresponsible conduct. They harbor no grudges.

The intelligence is intact. This is shown not only by formal tests, but also by the abilities as shown in everyday life and the working out of individual problems in occupation. The use of the intelligence is quite varied, however, depending not only upon its original quantity, but also on its training and more particularly upon the residual of self-consciousness and ambition that remains to the patient. Very complete subcortical amputation leaves the patient permanently crippled as far as effective use of the intelligence is concerned. Inadequate operation permits the return of the emotional distress that prior to operation prevented the patient from making effective use of his native endowment. A satisfactory operation relieves the misery and leaves the patient with his intelligence not only intact, but freed from the bonds of linkage with the self. We have taken particular pains to ascertain the occupational adjustment of our patients (Table I), and find that the majority are no longer dependent but are usefully even if not gainfully employed. When it is recalled that many patients in the younger schizophrenic

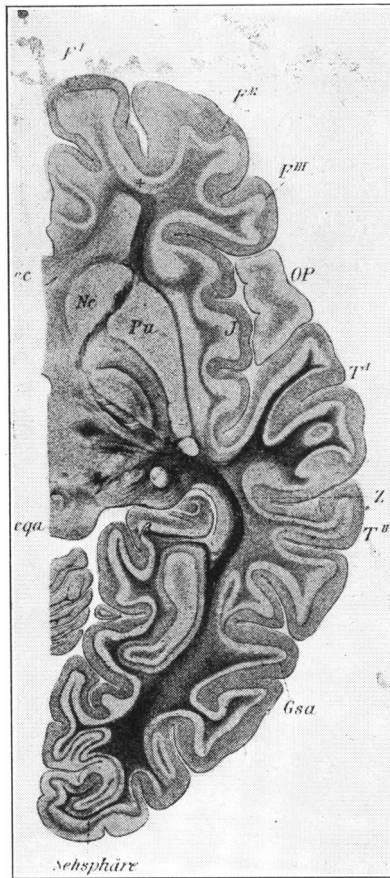


Fig. 5—Anterior thalamic radiation (+) in the 4 months child. This thalamo-frontal fasciculus becomes myelinated at a time when the association fibers are still immature [From Flechsig<sup>12</sup>].

group have never had jobs, and that the oldsters had retired, this record is not bad. Indeed, with two exceptions, patients who were working shortly prior to operation have been able to return to their employment.

The social behavior, then, is usually quite adequate, and the minor deviations are noted chiefly in hastiness and laziness neither of which is beyond the limits of normal, although both are novelties when the prepsychotic condition of the patient is considered. Teasing, exuberance, vulgarity, extravagance, gluttony and childishness are of uncommon occurrence after the convalescent period is past.

## MODUS OPERANDI

As was mentioned in an earlier section, iodized oil is injected into the incisions at the end of operation for roentgenographic control. Furthermore, we have had the opportunity to examine a few specimens post-mortem from successful and unsuccessful cases. As nearly as we can judge, the successful incision cuts through the white matter of the frontal pole just in front of the anterior horn of the ventricle and the genu of the corpus callosum. It remains strictly in the frontal lobe, but may cut slightly into the sylvian fissure in its anterior extension. The white matter is not completely interrupted, there being bands of fibers of considerable size all around the fan-shaped incisions. Study of the architecture of the frontal lobe connections in relation to these incisions demonstrates that some fibers of the corpus callosum, some of the superior longitudinal and inferior longitudinal fasciculi and the occipito-frontal fasciculus have been interrupted.<sup>12</sup> The fasciculus uncinatus appears to escape. Most importantly, we believe, the anterior thalamic radiation is more or less completely cut across at this level, and the fasciculus cinguli is sectioned in some cases (Fig. 5).

We have been unable to detect retrograde alterations in the cells of the cortex of the frontal pole. On the other hand, the cells of the nucleus medialis dorsalis of the thalamus show important degenerative changes, which increase directly with the extent of the lesion in the frontal lobe. This is the nucleus that projects to the frontal lobe as shown not only by animal experiments, but also by myelinization studies, and even by gross dissection (defibrillation)<sup>13</sup> of this part of the brain (Fig. 6). In summary, the operation of prefrontal lobotomy works through interruption of the system of fibers running from the thalamus to the frontal pole, without disturbing to any considerable degree the organization of the cerebral cortex. That some general shrinkage takes place in the frontal poles is evident in the gross specimens and also in the encephalograms taken on patients a couple of years after prefrontal lobotomy. The atrophy is slight in comparison with Pick's disease. The integrity of cortical activity is confirmed by the relative normality of most electroencephalograms taken some months after operation (Fig. 7).

A number of intelligent patients who have been able to furnish us with the results of their introspections have helped us to build up a certain series of ideas in regard to the effect of these incisions. Most im-

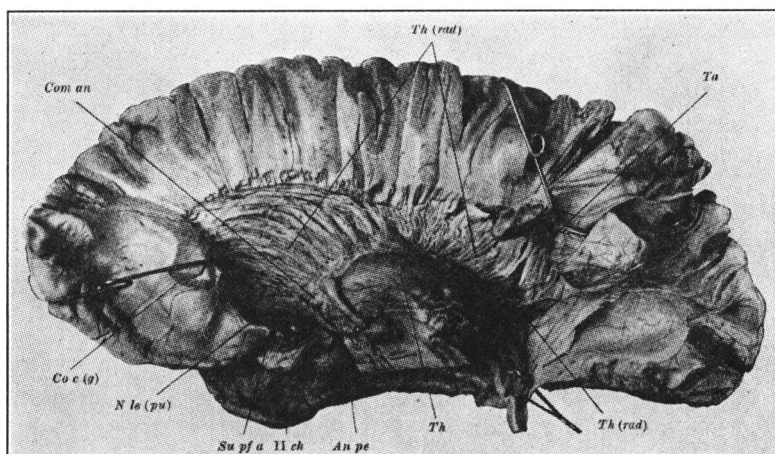


Fig. 6—Defibrillation preparation of adult brain showing anterior thalamic radiation [From Hultkrantz<sup>18</sup>].

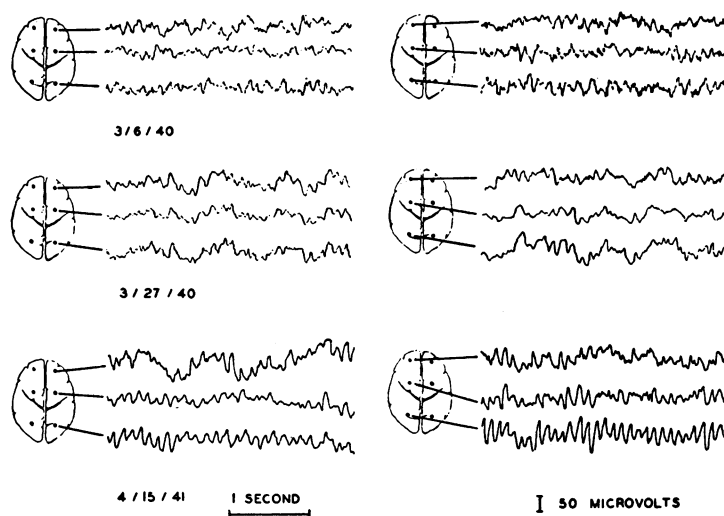


Fig. 7—Electroencephalograms from a case of chronic agitated depression [Kindness of Doctor Robert Cohn<sup>1</sup>].

portant among these is that prefrontal lobotomy diminishes the interest that the patient takes in his own feelings, sensations, reactions and ambitions. At the same time, there is a vivid interest in things outside himself. All tests show this trend toward extraversion. The patient enjoys life because he no longer suffers from indigestion; he is tactless because he no longer considers the consequences of an inept phrase; he is indo-

lent because he no longer is driven to attain that ideal of the self that he originally set in life. It is a very personal reaction, and also, as far as we can judge, almost entirely an emotional one. Patients know that their clothes are too tight, but they continue eating; they know that their tasks weigh too lightly upon them, but they prefer to read the comics; they know that their profanity is offensive but they do not care to bridle their tongues. As one man said of his wife: "She's so full of don't-give-a-damnness." The operation of prefrontal lobotomy would seem to produce its effects by divorcing imagination and affect *as they relate to the self*. Imagination and affect are both lively but they are turned outward rather than linked to the individual himself.

In certain previous studies we<sup>14</sup> have called attention to the function of foresight as being an important one carried out by the frontal lobes. We have observed this function badly disturbed for a period of time following operation, and then return. However, foresight in the recovered patient seems to turn much more to external things than to internal. This is shown in the successful occupational adjustment of patients whereas in their interpersonal activities, the qualities of abruptness, sauciness, tactlessness, and occasional lofty intransigence may furnish a startling contrast, particularly to the people who knew these patients previously as reserved, dignified, sensitive people. Patients know that they have behaved foolishly once the act is committed, and they may apologize for it but they cannot seem beforehand to form a mental picture of how they will appear after the act is performed, and even if they can, they do not have the emotional component that will restrain them altogether from saying the first thing that comes into their minds. We have often advised these people to get into the habit of counting ten before they speak, but they seldom get beyond five. It must be said, however, that their words and acts, once they have recovered their balance, seldom give offense. They are taken as ingenuous expressions of enthusiastic personalities.

#### PREFRONTAL LOBOTOMY AND PSYCHOPATHOLOGY

Prefrontal lobotomy reduces in greater or lesser degree the intensity with which the individual regards himself. Stated more succinctly, the operation bleaches the affect attached to the ego. Whether this is a good thing will have to be determined by examination of the relationship of these two functions in the sick individual rather than upon

theoretical grounds as related to the normally functioning personality.

The mentally sick individual is fundamentally a person whose ideational activities revolve largely around himself, whose interest in the outside world is more or less markedly restricted, and whose affective experiences largely dominate his behavior. The hypochondriac shows this just as clearly in the somatic field as the paranoid does in the social field. The obsessive thinker may have insight into the falsity or foolishness of his ideas but he is just as unable to control them as the schizophrenic is unable to control his hallucinations. Indeed, we have arrived at the opinion that it is not the ideas that matter; anybody may have the most abnormal ideas and still retain his mental health. It is the *fixation* that counts. When an idea becomes fixed, it is no longer harmless and may produce serious results. We have drawn the comparison of such fixed ideas with the sensitized photographic film. When light falls on such a film through the lens of the camera, there is a certain physical alteration in the silver emulsion that cannot be detected until a reducing agent is applied. Once the developer acts, the image is brought out. If the developer is allowed to act for a long time, the silver is all reduced and the image fades back into obscurity. If, however, at the proper time, a fixative is applied, the image remains in spite of further light and further chemical reduction. It is the *fixation* that causes the image to persist.

Now, in the case of abnormal ideas, as was said before, anybody can have them and still remain normal, but if such ideas become fixed, they have not only permanence but also noxious potentialities. And, if we are correct, it is emotion that fixes the ideas. Further elaboration of pathologic ideas consequent upon the fixation involves such phenomena as delusions, obsessions, compulsions, states of tension, suicidal ideas, and, through possible exhaustion and independent "firing" of different cortical areas, to hallucinations, stereotypy, mannerisms, verbiage and all the welter of schizophrenic symptomatology.

We do not insist upon acceptance of this concept of elaboration of psychotic symptoms, but it is quite noteworthy that prefrontal lobotomy is followed by loss of interest (affect!) in the hallucinatory and delusional experiences as well as in the bodily sensations, obsessions and so on, even though these phenomena persist for a time. As one very intelligent patient expressed it, "The sensation has moved from the center of my attention to the periphery." The cutting of the thalamo-

frontal radiation has thus deprived the ideational activities of their power to distress the patient. He is no longer affectively observant of his inner experiences and can therefore turn his attention to happenings in the outer world. The same pathologic ideational activities persist for a longer or shorter period, and the motor manifestations are brought under control even more slowly, but the bleaching of the affect has acted to return the ideas to the misty obscurity of the unimportant.

One might say that through the operation of prefrontal lobotomy, the destructive imagination of the patient is reduced to the point where he can again live at ease with himself and that the constructive imagination is relatively intact as far as external things are concerned. The great reduction in the consciousness of the self, however, renders the social readjustment of the patient a difficult matter at times, precisely because of his lack of concern about himself. Since it was his concern over himself and his own situation that seemed in large measure responsible for the mental breakdown in the beginning, the operation represents a radical attack, literally as well as figuratively, upon his psychosis. Furthermore, the disparate effects upon the patient and upon the family are apt to be of some moment in certain patients. If the patient is relieved of his burden of psychosis to the extent that his ebullience becomes a matter of uneasiness and hardship to the family, the result, from the social standpoint, leaves something to be desired.

We have to estimate the prepsychotic behavior of the individual before going ahead with the operation. Patients who have shown aggressive, psychopathic, criminal and alcoholic traits are refused operation no matter how clamorous they are, on the ground that their behavior after operation might be too offensive for social tolerance. Unfortunately for their families (the patients are always pleased) some cases have slipped by us without sufficient preoperative estimation and have proved troublesome problems. Also, we believed on theoretical grounds that alcoholics, if they were relieved of their states of tension would become good citizens. A couple of bitter experiences have taught us that prefrontal lobotomy is no cure for alcoholism. However, only one patient has developed alcoholism following prefrontal lobotomy.

#### RESULTS OF PREFRONTAL LOBOTOMY

The tabulated results of prefrontal lobotomy (Tables I and II) may be viewed as too optimistic, particularly after the foregoing discussion

TABLE II  
RESULTS OF PREFRONTAL LOBOTOMY

<i>Disease</i>	<i>No.</i>	<i>Results</i>			<i>Deaths</i>	
		<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Operative</i>	<i>Subsequent</i>
Involucional Depressions	62	48	10	3	1	7
Obsessive Tension States	30	22	4	2	2	
Schizophrenias	31	21	5	5		1
Psychoneurosis	8	6	1	1		
Undifferentiated (Schizoid)	5	1	3	1		
Totals	136	98	23	12	3	8

of the erratic behavior of the patients as described in previous sections. On the other hand, the figures include a number of patients who were operated upon during the first year of our endeavors (with the inadequate Moniz technique) and recent results have shown improvement. Moreover, with the passage of time there is often further improvement in the social adaptation of the patients, even through the third and the fifth year. This is in striking contrast with the results reported from the shock therapies, where relapses are not uncommon.

The factor of choice of patients is obviously important. During the first years, the emphasis was upon the involucional psychotics, and few schizophrenics were chosen for operation. Then, as relapses occurred from insulin and metrazol shock therapy, prefrontal lobotomy was employed in some of these cases. The patients selected were those whose families could afford rather satisfactory aftercare, and the majority of patients had not been institutionalized over any long period. It is not to be expected that results similar to ours could be obtained in chronic institutional patients, although we have noted some strikingly successful instances in patients hospitalized for more than five years.

It will be seen from the figures that the most successful cases are classed as obsessive tension states, with or without compulsions. These patients are intelligent and have considerable native energy drive, and they have not become dissociated. However, they are apt to be slow in making a satisfactory social adaptation because of the tendency to





A



B

Fig. 8—Photographs of a patient with agitated depression of eight years duration. (A). Before operation. (B). One year after operation.

aggressive behavior. In this connection, I may quote a paragraph from a letter received from the father of a patient: "A sense of gratitude, approaching mild elation is very noticeable, that his old difficulties are now gone forever. He speaks of getting married sometime and having children. Better judgment is also manifesting itself. He is not quite the

same David he used to be and probably never will be. With the passing of the intense, subjective emotionalism, a little of the good might also be lost, but this is of little moment, for a self directing hopeful personality is emerging, and this means everything.”

The patients suffering from involutional depression are very satisfactory as a rule, although quite a number of them remain at home without useful occupation. In these cases, the illness has often led to retirement from business or domestic responsibility some time previous to operation, and the patients remain in retirement. We are particularly interested in relieving these patients of the burden of an over-worked conscience, believing that even if they are unable to resume their former responsibilities, they deserve a modicum of comfort in their advancing years. It may be argued that these patients respond particularly well to shock therapy and that prefrontal lobotomy is unnecessarily radical. Shock therapy has been tried unsuccessfully or with relapse in most of these patients. The others have been of the type that in our opinion would not respond satisfactorily to shock therapy (Fig. 8).

As far as schizophrenics are concerned, the results leave much to be desired. This is true, however, of any treatment with which we are familiar. The surprising thing is that so many of them have been able to get along outside of an institution even if not usefully employed. The patients in the other groups are too few for any valid conclusions.

#### SUMMARY AND CONCLUSIONS

1. Prefrontal lobotomy interrupts the connection between the frontal lobe and the thalamus, thereby reducing the emotional reactions of the patient as regards himself. This loss of painful self-consciousness in the psychotic patient is followed by reintegration of the personality with the ideational activities directed outward.

2. Intelligence is unharmed, but the application of that intelligence to the interplay of social and personal influences concerning the individual himself is diminished and in some patients results in indolence and lack of tact.

3. Many patients are able to reach their prepsychotic level of occupational adjustment. Some do even better.

4. Failures are due to:

- a. Inadequate operation. This may be corrected by a secondary more complete lobotomy.

- b. Too extensive operation. It is better to cut too little than too much.
- c. Inadequate evaluation of the aggressive traits of the patient previous to the development of his psychosis.
- d. Emotional deterioration. When the psychotic patient has given up the fight, it is probably too late for psychosurgery.
5. Old people whose lives are a burden to themselves by reason of psychosis are particularly good subjects for prefrontal lobotomy because of the serenity of disposition that follows operation.
6. Best results are obtained in obsessive tension states. Good results are obtained in involutional depressions. Fair results are obtained in schizophrenias. Poor results are obtained in alcoholism.
7. Finally, prefrontal lobotomy is comparable in its effects with the neurosurgical operations directed toward the relief of pain; only in these cases it is mental pain that is relieved.

## REFERENCES

1. Freeman, W. and Watts, J. W. *Psychosurgery; intelligence, emotion and social behavior following prefrontal lobotomy for mental disorders*. Springfield, Thomas, 1942. (Full bibliography to Sept. 1941).
2. Burckhardt, G. Ueber Rindenexcisionen, als Beitrag zur operativen Therapie der Psychosen, *Allg. Ztschr. f. Psychiat.*, 1890-91, 47:463.
3. Puusepp, L. Alcune considerazioni sugli interventi chirurgici nelle malattie mentali, *Gior. d. r. Accad. di med. di Torino*, 1937, 100:3.
4. Egas Moniz, A. C. de A. F. *Tentatives opératoires dans le traitement de certaines psychoses*. Paris, Masson, 1936.
5. Ody, F. Le traitement de la démence précoce par résection du lobe préfrontal, *Arch. ital de chir.*, 1938, 53:321.
6. Harlow, J. M. Passage of an iron rod through the head, *Boston M. & S. J.*, 1848, 39:389.
7. Bianchi, L. *The mechanism of the brain and the function of the frontal lobes*; translated by J. H. MacDonald. Edinburgh, Livingstone, 1922.
8. Ferrier, D. *The functions of the brain*. 2. ed. London, Smith, Elder & Co., 1886.
9. Rylander, C. G. *Personality changes after operations on the frontal lobes; a clinical study of 32 cases*. London, Oxford Univ. Press, 1939; also published in *Arch. psychiat. et neurol.*, 1939, suppl. 20.
10. Brickner, R. M. *The intellectual functions of the frontal lobes; a study based upon observations of a man after partial bilateral frontal lobectomy*. New York, Macmillan, 1936.
11. Watts, J. W. and Freeman, W. Surgical aspects of prefrontal lobotomy, *J. Internat. Coll. Surg.*, 1942, 5:233.
12. Flechsig, P. E. *Anatomie des menschlichen Gehirns und Rückenmarks auf myelogenetischer Grundlage*. Leipzig, Thieme, 1920.
13. Hultkrantz, J. W. *Brain preparations: by means of defibrillation or blunt dissection; a guide to the macroscopic study of the brain*. London, Heine-mann, 1935.
14. Freeman, W. and Watts, J. W. An interpretation of the functions of the frontal lobes based upon observations in 48 cases of prefrontal lobotomy, *Yale J. Biol. & Med.*, 1939, 11:527.